People who make no noise are dangerous.

– Jean de la Fontaine
(French poet, 1621-1695)

Noise is inevitable, but not insurmountable. We are not going to give you a lecture on acoustics in this chapter. Instead we will present some common terms and straightforward solutions to help you avoid and overcome basic acoustic problems.

Why you should choose Rockfon

Highest class of sound absorption

- By nature, Rockfon ceilings, wall absorbers and baffles have excellent sound absorption properties.
- Aesthetically pleasing smooth surfaces – without reliance on aesthetically challenging acoustical 'perforations' or 'holes'.
- All declared values are tested in independent and certified laboratories.

Best sound absorption in the speech frequency range

- Rockfon ceilings perform even better in the speech frequency range contributing to better speech intelligibility.

Best combination of sound absorption and sound insulation

- Only Rockfon Sonar dB tiles can provide both Class A sound absorption and a high level of sound insulation with $D_{n,f,w}$ values up to 44 dB.
- Extensive sound insulation documentation from certified laboratories e.g. with light fittings, sound barriers and absorbing overlay material in plenum.

Best multi-angle sound absorption

- Due to the acoustical porosity of stone wool and the specially formulated, thin and acoustically 'open' surfaces, Rockfon ceilings efficiently absorb sound from all incident angles.

Selection table: Acoustics

	Page	Acoustic data measured at: Thickness of tile (mm)	Suspension height (mm)	Absorption class	α_w*
MONOLITHIC CELING					
MonoAcoustic	62	30	-	B	0.85
DESIGN WHITE					
Sonar	68	20	200	A	1.00
Sonar Activity	70	40	200	A	1.00
Sonar Alto	72	20	200	E	0.20
Alaska	74	20	200	A	1.00
Alaska dB 35	80	25	225	B	0.80
Alaska dB 40	82	30	230	B	0.85
Sonar dB 40	86	30	230	B	0.85
Sonar dB 44	88	50	250	A	0.90
DESIGN DECORATION					
Sonar Luna	90	20	200	A	0.95
Ligna	94	20	200	B	0.85
Selva	98	20	200	A	0.95
Polar Colour	102	15	200	A	0.95
BASIC WHITE					
Koral	108	15-25	200	A	0.90
Koral Tenor	110	15	200	C	0.60
Pacific	112	12	200	C	0.60
		15	200	C	0.70
SPECIAL AREA					
Hygienic					
Hygienic	118	20	200	A	0.90
		40	200	A	0.95
Hygienic Plus	120	20	200	A	0.90
		40	200	A	0.95
Healthcare					
MediCare	124	15-25	200	A	0.90
		20	200	A	0.95
MediCare Plus	126	20	200	A	0.90
MediCare Ultra	128	20	200	A	0.90
		40	200	A	0.95
Impact Resistance					
Samson	130	40	200	A	1.00
Education					
Scholar	134	20	200	A	0.90
		40	200	A	0.95
OTHER					
Wall Absorbers					
Samson	140	40	40	B	0.80
Scholar	140	40	40	A	0.95
Sonar Activity	142	40	40	A	0.95
Polar Colour	142	40	40	B	0.85
Industrial					
Industrial Ceiling Panel Off White	146	50	200	A	1.00
Industrial Ceiling Panel Black	146	50	200	A	1.00
Baffles*					
Fibral Multiflex (1200 x 600)	152	50	-	C	0.70
Opal Multiflex (1200 x 450)	152	50	-	C	0.65
Hygienic (1200 x 600)	152	50	-	C	0.70

* α_w and absorption class is measured at 200mm construction height unless otherwise specified.

** $D_{n,f,w}$ value is measured in a lab according to ISO 10848-2. The total sound insulation of a construction is dependent on a lot of factors, e.g. partition walls, celing type (e.g. material, tile dimensions and edge types), cut throughs and connections.

*** Data based on 1 baffle per m^2

This table is your quick reference for finding the right product based on ACOUSTIC needs.
If you need further background information about acoustics you can find it on the following pages.

α_p							
125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	$D_{n,f,w}$** ($C;C_{tr}$)	R_w ($C;C_{tr}$)
0.45	0.80	0.80	0.80	0.85	0.75		
0.45	0.85	1.00	1.00	1.00	1.00		
0.50	0.80	0.95	1.00	1.00	1.00		
0.35	0.25	0.15	0.15	0.25	0.20		
0.45	0.85	1.00	0.95	1.00	1.00		
0.35	0.55	0.80	1.00	1.00	1.00	35 dB (-2;-8)	19 (-1;-3)
0.35	0.55	0.95	1.00	1.00	1.00	40 dB (-2;-6)	21 (-1;-2)
0.35	0.55	0.95	1.00	1.00	1.00	40 dB (-2;-6)	21 (-1;-2)
0.40	0.60	0.95	1.00	1.00	1.00	44 dB (-1;-7)	27 (-1;-4)
0.45	0.75	0.95	0.90	1.00	1.00		
0.45	0.75	0.85	0.80	0.90	0.95		
0.50	0.75	1.00	0.90	0.95	0.80		
0.40	0.75	0.95	0.90	1.00	1.00		
0.45	0.80	0.95	0.80	0.90	0.85		
0.55	0.60	0.60	0.55	0.60	0.45		
0.55	0.65	0.60	0.55	0.65	0.50		
0.40	0.65	0.65	0.65	0.70	0.70		
0.45	0.90	0.95	0.85	0.90	0.85		
0.50	0.90	0.95	0.95	0.95	0.85		
0.45	0.90	0.95	0.85	0.90	0.85		
0.50	0.90	0.95	0.95	0.95	0.85		
0.45	0.80	0.95	0.80	0.90	0.85		
0.45	0.75	0.90	0.90	1.00	1.00		
0.50	0.70	0.90	0.85	0.95	0.85		
0.45	0.90	0.95	0.85	0.90	0.85		
0.50	0.90	0.95	0.95	0.95	0.85		
0.45	0.85	1.00	1.00	1.00	1.00		
0.50	0.70	0.90	0.85	0.95	0.85		
0.55	0.75	0.95	0.95	0.95	0.80		
0.15	0.50	1.00	1.00	1.00	1.00		
0.20	0.70	1.00	1.00	0.95	0.90		
0.30	0.70	0.90	1.00	1.00	1.00		
0.10	0.55	0.95	1.00	1.00	0.95		
0.55	0.90	1.00	1.00	1.00	1.00		
0.55	0.90	1.00	1.00	1.00	1.00		
0.35	0.45	0.70	0.85	0.85	0.85		
0.30	0.40	0.60	0.75	0.75	0.75		
0.30	0.40	0.75	0.85	0.85	0.85		

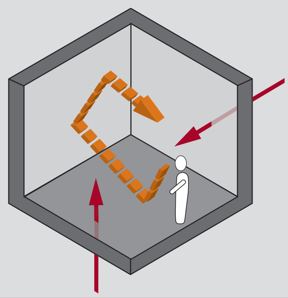
Acoustics is the science of sound

Acoustic well-being in spaces is primarily determined by two factors:

- *sound absorption*
- *sound insulation*

ROOM ACOUSTICS
Room acoustics describes how sound behaves in an enclosed space. It deals with the sound propagation inside a room: sound absorption, reflection and diffusion on all surfaces and objects in the room.

BUILDING ACOUSTICS
Building acoustics deals with the sound propagation through a building element i.e. partition wall, separating floor construction, facade, window, etc.



SOUND ABSORPTION
When a sound wave hits a material, part of the energy is reflected, another part is absorbed in the material and some is transmitted. The sound absorption coefficient α is the ratio of the absorbed sound energy to the incident sound energy. The result is a coefficient between 0 and 1 where 1 means that all sound is absorbed and 0 means that no sound is absorbed but all sound is reflected.

Sound absorption is important for the users' acoustic experience of the room. The appropriate amount of sound absorption makes the space suitable for its intended use: it controls the sound level, prevents undesirable effects, reduces disorientation and increases speech intelligibility.

The effectiveness of sound absorption is determined by the interior layout of the space and the materials used in it.

Spaces with inadequate or no sound-absorbing materials tend to be too reverberant and produce echoes. An echo is generated by sound reflecting from surfaces and objects in the space multiple times. The three main problems caused by too much echo are:

1. Disorientation:
Sound is received by the listener from all directions at more or less the same volume level. The sound level is virtually the same everywhere in the space. The direction of the sound source cannot be determined, and the result is disorientation. Disorientation has a negative influence on concentration.

2. Poor speech intelligibility:
The many reflections combine and make speech unintelligible or difficult to understand.

3. 'The cocktail party effect':
In an informal situation, people speaking are disruptive to each other because the sound level is practically the same everywhere in the space. The people in the room talk louder and louder until everyone is shouting. This is known as the cocktail party effect. The cocktail party effect has been responsible for sound levels in kindergartens being measured at over 90 dB(A), far higher than the level at which noise-induced hearing loss can occur.

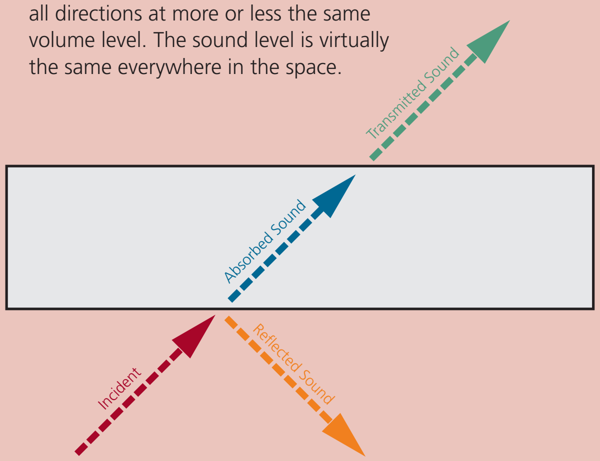
SOUND INSULATION
Sound insulation is the degree to which sound is prevented from penetrating into another space. The sound insulation influences the sound level in the receiving space, and therefore affects:

- privacy;
- the ability to concentrate in the receiving space.

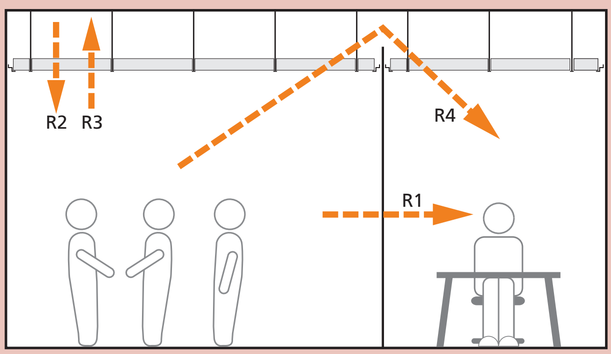
The desired level of sound insulation depends on the circumstances. There are very few requirements for sound insulation for two adjacent spaces with low privacy / non sensitive activities and low sound levels. If a space such as a management office is adjacent to one of these spaces, the sound insulation requirements are very high.

In buildings, sound can transfer to adjacent spaces in various ways:

- **Direct sound:** through certain constructions such as a partition wall, or from the plenum through a suspended ceiling. The latter case may involve equipment sound or the like;
- **Longitudinal sound:** sound that transfers via the suspended ceiling, into the plenum and then via the suspended ceiling of the adjacent space;
- **Impact sound:** this is sound that transfers to other spaces by direct contact with the construction, e.g. footsteps;
- **Flanking sound:** this is sound that transfers to other spaces via 'short circuit' routes - this can be caused by common ceiling plenums, poorly isolated floors, services etc.



Good detailing and workmanship is essential to maximise performance.



R1, R2 and R3 represent direct sound insulation.
R4 represents longitudinal and flanking sound insulation.

Peter is not stupid

– he just can't hear nor understand what the teacher is saying.

When sound becomes noise, people get irritated and stressed. This is not only true in schools, but also in offices, hospitals, and other public buildings.

Many scientific and empirical studies describe the impact of poor acoustics:

- In schools, up to 70% of the consonants spoken by teachers cannot be heard by pupils.[1]
- In open plan offices, 60% of employees say that noise is the single most disturbing factor.[2]
- In offices, 70% of employees believed that their productivity would be higher if their environment was less noisy.[3]
- In offices, normal noise reduces the effectiveness in cognitive tests by 66% compared to the level in quiet surroundings.[3]
- Sales in a retail shop can increase by 5-10% as a rule of thumb through acoustic improvement measures.[3]
- In hospital environments, noise control is very important to the recovery of patients as "unwanted sound" can increase heart rate, blood pressure and respiration rate.[4]

1) "Speech Intelligibility in Classrooms" research project conducted by The Department of Building Engineering & Surveying of Herriot-Watt University in Edinburgh
2) Danish National Research Center for Working Environment: "Noise from human activity"
3) Julian Treasure, Sound Business, 2007
4) Source: Health Technical Memorandum 08-01: Acoustics

What regulators do about acoustics

Rockfon ceilings play a major role in enhancing acoustics through:

- **lowering sound pressure levels**
- **optimising reverberation times**
- **optimising speech intelligibility**
- **increasing sound insulation**

Due to the scientifically proven importance of acoustics on peoples' health and performance, acoustic regulations are developing rapidly and expert associations are publishing best practice for all types of private and public spaces. Therefore, good acoustics is no longer a matter of fate, but something to which designers, architects and acousticians can actively contribute.

Good acoustics can not be achieved by optimizing one single parameter. It's a set of factors which need to be aligned to the purpose of the room. Most regulations and guidelines refer to 4 key aspects:

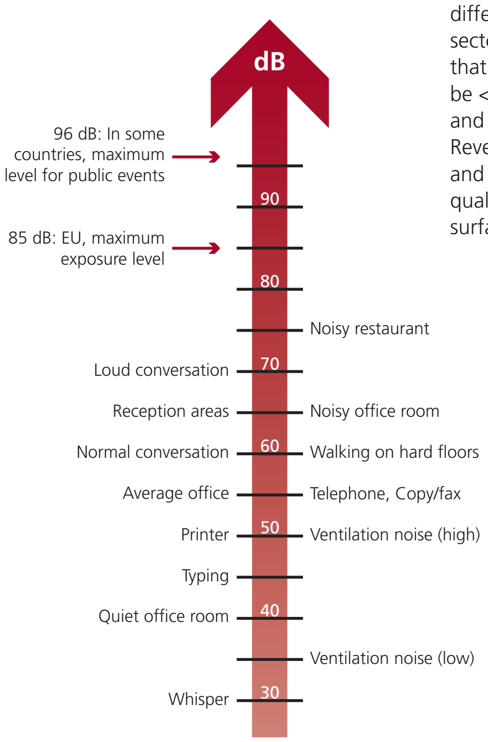
- **Sound pressure level:** How loud is it?
- **Reverberation time:** How much echo is in the room?
- **Speech intelligibility:** How well can words can be understood?
- **Sound insulation:** How much noise is blocked between two rooms?

These parameters are described in the following section. For a more detailed explanation, please refer to the Rockfon website: **www.rockfon.co.uk**

SOUND PRESSURE LEVEL

The sound pressure level indicates how loud it is in a space. Both, high sound pressure peaks and a high average sound pressure levels over time can lead to serious health damage. The European Union has defined maximum exposure levels at 85 dB(A) and in some countries public events, like concerts, should not exceed 96 dB(A). Average sound pressure level is not only relevant in factories because it can also reach very high levels in for example kindergartens.

The sound pressure level in a room depends on the strength of the sound source(s), the room shape and the amount and quality of sound absorbing surfaces.

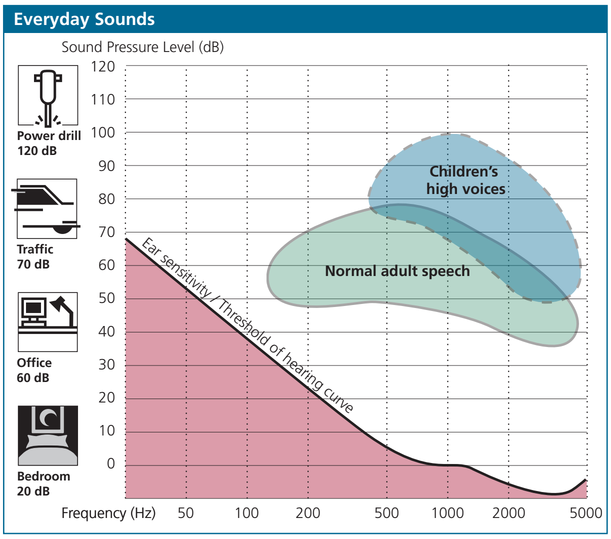


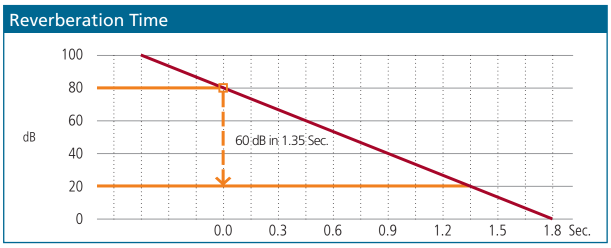
REVERBERATION TIME

The most important factor common to all regulations is reverberation time. This is defined as the time it takes – in seconds – for the sound pressure level to drop by 60 dB after a source stops generating the sound. In most situations, a short reverberation time improves acoustic comfort. Speech is best understood with short reverberation times and without echo.

However, in some situations, such as concert halls and cathedrals, longer reverberation times can be required to ensure a comfortable acoustic and listening experience.

Most regulators and expert associations define maximum reverberation times for different room types in different building sectors. For example, it is generally agreed that acceptable reverberation times should be < 0.4 s for an all inclusive classroom and < 0.5 s for an open plan office. Reverberation time is dependent on the size and shape of the space and the amount, quality, and positioning of absorbing surfaces within the space.





BEST IN THE INDUSTRY

Rockfon ceilings and room acoustic solutions provide the highest sound absorption performance in the industry with enhanced performance in the speech frequency range. With Rockfon, you need less material i.e. less absorbing surface area to achieve optimum reverberation times and good speech intelligibility.

SPEECH INTELLIGIBILITY

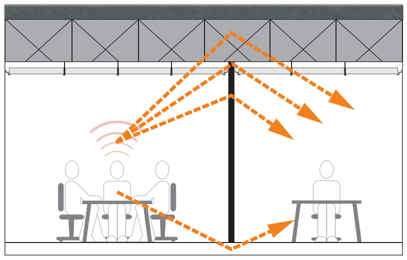
Speech intelligibility is an expression for how well speech can be heard and understood in a room. Many factors have an influence on the level of speech intelligibility. For example, the speech signal itself, the direction of the source sound, the background noise level, the reverberation time of the room and the room shape. A short reverberation time will e.g. enable a listener to hear and understand the first word – and the sound from that will die out before the sound of the next word reaches the listener. Also, if the sound is drowned in background noise, the listener will have difficulty understanding what is being said.

SOUND INSULATION

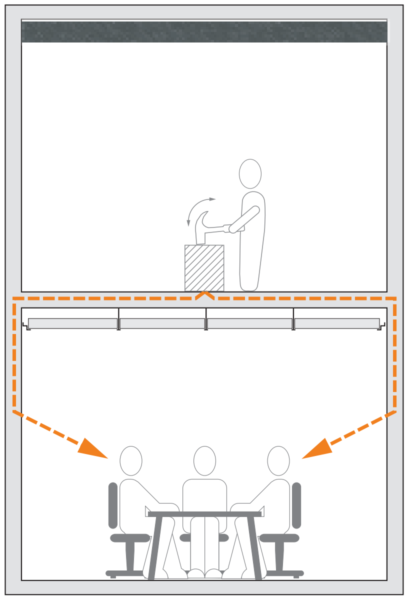
The total airborne sound insulation between adjacent spaces expressed by the $D_{nT,w}$, (D_{nT}(Tmf,max),w in the case of schools), R'_w or $D_{nT,A}$ values represents the ability of a total construction i.e. partition + ceiling + floor and the connections / flanking between these to block speech, music or other sound transmitted through the air and building elements. It is rated in dB and the higher the value the better the performance. Some regulators specify minimum levels of 35-45 dB between offices, 45-50 dB between school classrooms and 50-60 dB between apartments and dwellings.

Mass, air-tightness and sound absorption are the primary properties that determine the ability of a material to insulate against sound.

The impact sound insulation between the floors of a multistorey building is an expression of the ability of the floor construction to insulate against the sounds generated by direct contact / impacts e.g. footsteps, slamming doors. It is characterised by the impact sound pressure level L'_{nT},w (L'_{nT}(Tmf,max), w in the case of schools) and is rated in dB. The lower the value, the lower the sound pressure level thus, the better the impact sound insulation. Some regulators specify maximum L'_{nTw} levels of 60 dB in classrooms and offices.



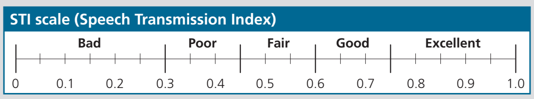
Sound transmission paths between adjacent spaces



Impact sound transmission

STI VERSUS RASTI

The most popular way of expressing the level of speech intelligibility is by the use of the Speech Transmission Index (STI) value. This index quantifies the speech intelligibility in a scale from 0 to 1. E.g. in an open plan classroom the level should be > 0.6.



Another commonly used variant is the Rapid Speech Intelligibility Transmission Index (RASTI). This is basically the same as STI, but measured according to a simplified (rapid) measurement procedure. Some regulators have decided to use STI instead of reverberation time as a guideline for room acoustics in larger open plan spaces.

Since reverberation time is closely linked to speech intelligibility, the amount, performance and positioning of absorbing surfaces strongly influences the speech intelligibility of a space.

ROCKFON RECOMMENDATIONS FOR THE DIFFERENT ROOM TYPES

OFFICE	Rockfon Recommendations*
Cellular office	T ≤ 0.6 sec.
Open-plan office	T ≤ 0.5 sec.
EDUCATION	
Classroom (Primary)	T ≤ 0.4 - 0.6 sec.
Classroom (Secondary)	T ≤ 0.4 - 0.8 sec.
Classroom (Open plan)	T < 0.8 sec., STI > 0.60
Classroom (All inclusive)	T ≤ 0.4 sec., STI > 0.60
Classroom (Music)	T < 1.0 sec.
Gymnasium	T < 1.5 sec.
Swimming pool	T < 2.0 sec.
Stairwell	Min. Class C ceiling covering > 50% stair / floor area
Corridors	Class A ceiling covering > 90% floor area
Multi-purpose hall	T = 0.8 - 1.2 sec.
DAYCARE CENTRES	
Standard room	T ≤ 0.4 sec.
Large rooms (ceiling height > 4 m, vol. > 300 m³)	T ≤ 0.4 sec., STI > 0.60.
HOSPITALS	
Ward / Examination room	Class A ceiling covering > 90% floor area
Corridor / Street	Class A ceiling covering > 90% floor area

T = Reverberation time
A = Equivalent absorption area
STI = Speech Transmission Index

** Rockfon recommendations are based on AD.E, BB 93, HTM 08-01 & BS 8233.*

How to compare ceilings in terms of sound absorption

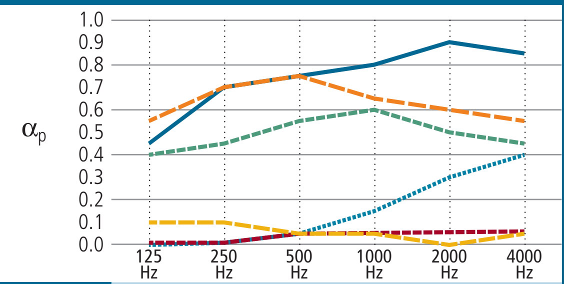
Rockfon is made with a pure stone wool core, which by nature is a highly sound absorbing material.

This means that a high proportion of the sound waves 'seen' by Rockfon material are not reflected but absorbed. As a result the sound pressure level in the room is reduced, the reverberation time is reduced and the speech intelligibility is improved.

Most ceiling tile experts agree that sound absorption is the single most important acoustic parameter as it has a positive influence on sound pressure level, reverberation time, speech intelligibility and sound insulation. Therefore, sound absorption is part of ceiling CE marking and ceiling systems suppliers must declare the sound absorbing performance for all their products, if this feature is communicated to the market.

For construction products, sound absorption is measured in third octave band frequencies from 100 Hz to 5000 Hz. The sound absorption coefficient at specific frequencies indicates the ratio between the absorbed sound energy and the incident sound energy. The result is a coefficient between 0 and 1 where 1 means that all sound is absorbed (100% efficiency). Sound absorption is expressed today in a number of different ways – some methods are better than others.

Sound Absorption Coefficients



	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz
Rockfon Sonar	0.45	0.70	0.75	0.80	0.90	0.85
Perforated Gypsum	0.55	0.70	0.75	0.65	0.60	0.55
Wetfelt Tile	0.40	0.45	0.55	0.60	0.50	0.45
Carpet	0.01	0.02	0.05	0.15	0.30	0.40
Stone/Linoleum	0.02	0.02	0.05	0.05	0.05	0.07
Unperforated Gypsum	0.10	0.10	0.05	0.05	0.00	0.05

SOUND ABSORPTION IS DIRECTLY RELATED TO REVERBERATION TIME:

Sabine Formula for Reverberation Time:

$T = 0.16 \cdot (V/A)$

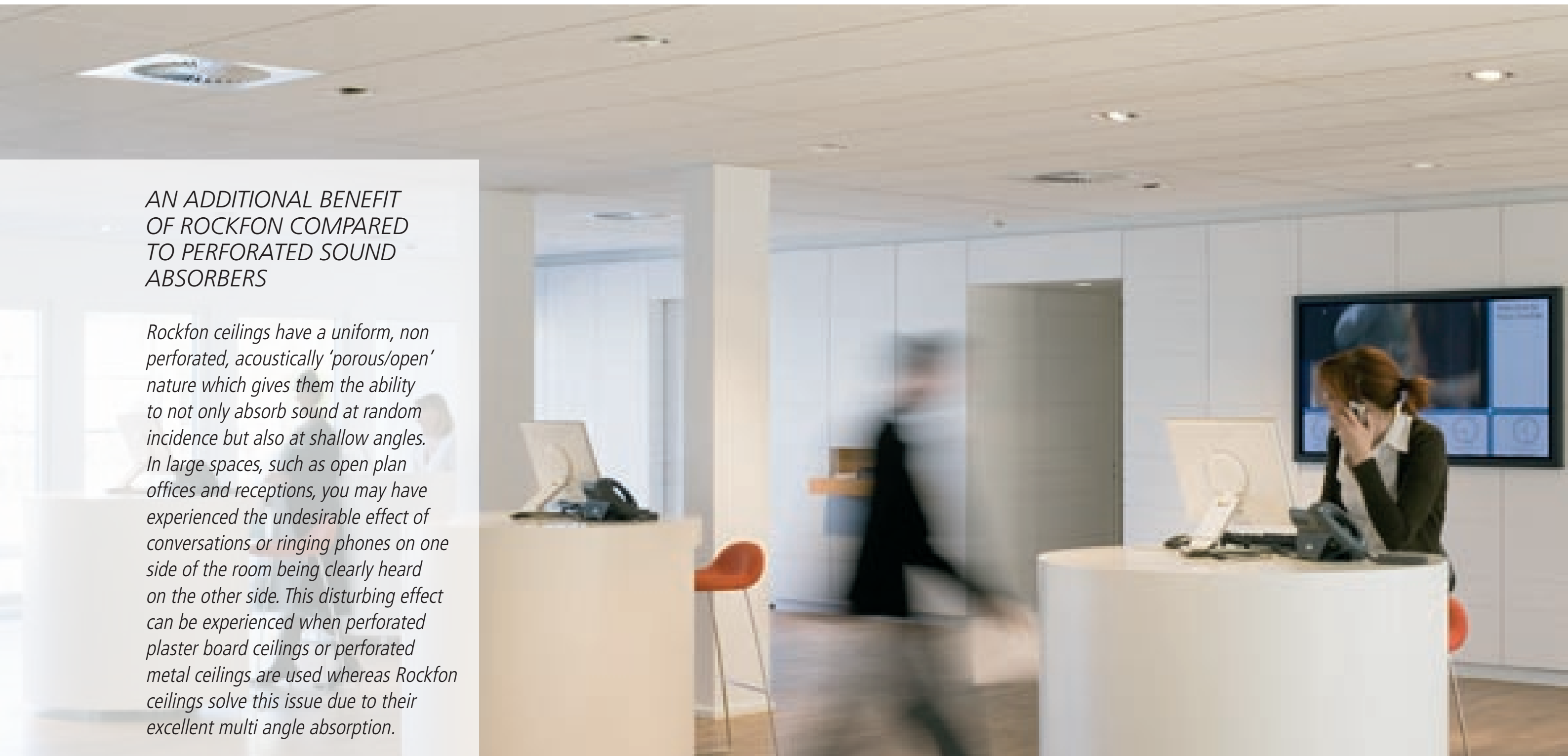
Where:

- T = reverberation time
- V = volume of the space
- A = total room absorption = $\Sigma\, \alpha \cdot S$

Where:

- S = surface area of material
- α = sound absorption coefficient

This means that for a given room, 50m² of acoustic material with 0.5 sound absorption (i.e. 25 units of absorption) will only contribute as much to the reverberation time as 25m² of acoustic material with 1.0 sound absorption. So the higher the products' absorption – the less you need. This can be extremely beneficial in many applications - meaning less material to purchase, reduced installation time, reduced overall cost, enhanced suitability for thermal mass applications etc.



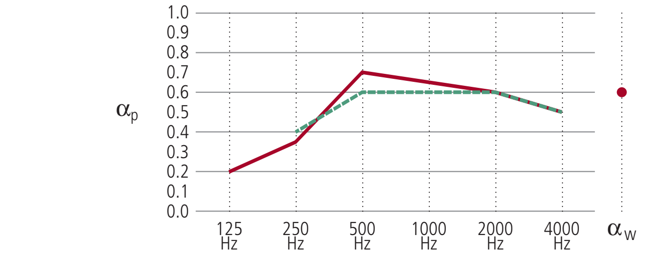
AN ADDITIONAL BENEFIT OF ROCKFON COMPARED TO PERFORATED SOUND ABSORBERS

Rockfon ceilings have a uniform, non perforated, acoustically 'porous/open' nature which gives them the ability to not only absorb sound at random incidence but also at shallow angles. In large spaces, such as open plan offices and receptions, you may have experienced the undesirable effect of conversations or ringing phones on one side of the room being clearly heard on the other side. This disturbing effect can be experienced when perforated plaster board ceilings or perforated metal ceilings are used whereas Rockfon ceilings solve this issue due to their excellent multi angle absorption.

WEIGHTED SOUND ABSORPTION COEFFICIENT (α_w)

Calculated in accordance with ISO 11654 using the practical sound absorption coefficient α_p values at standard frequencies and comparing them with a reference curve. The practical sound absorption coefficient α_p is the average of the three 1/3 octave α_s values centred on the octave band frequency and rounded in steps of 0.05. The α_w reference curve is shifted downwards in increments of 0.05. This shifts the reference curve to the point where the sum of the negative deviations from the measured values is ≤ 0.10. When this level is reached, the α_w value is recorded as the value of the reference curve at 500 Hz. α_w is communicated by all suspended ceiling suppliers in Europe as it is the method which has been adopted as the norm for CE marking of suspended ceilings.

Weighted sound absorption coefficient (α_w)

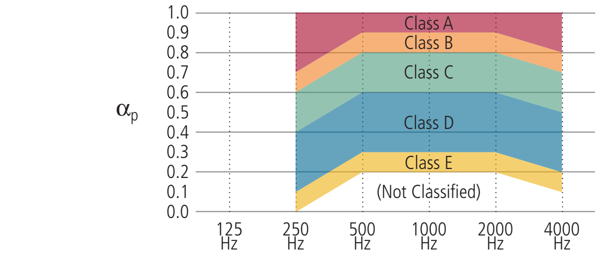


	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	α_w
Absorber	0.20	0.35	0.70	0.65	0.60	0.55	0.60
Reference Curve	–	0.40	0.60	0.60	0.60	0.50	

ABSORPTION CLASSES

Absorption classes A to E are described in international standard ISO 11654. To determine the class, the α_w values are compared to a series of fixed reference curves. As the range between the reference curves is wide, absorption classes only provide a general indication of the absorption characteristics of materials.

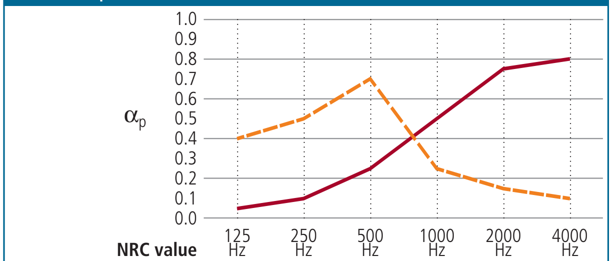
Absorption classes



NOISE REDUCTION COEFFICIENT (NRC)

Calculated in accordance with ASTM C423; it is the mathematical average of the measured sound absorption coefficient α_s at frequencies 250, 500, 1000 and 2000 Hz. This method gives equal weighting across the frequency range and does not provide a very useful value. This illustration shows that two materials with very different sound absorption characteristics result in the same NRC value.

NRC comparison



	NRC value	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz
Red	**0.40**	0.05	**0.10**	**0.25**	**0.50**	**0.75**	0.80
Orange	**0.40**	0.40	**0.50**	**0.70**	**0.25**	**0.15**	0.10

α_w	Absorption class	NRC
0.90	A	0.85
0.95	A	0.90
0.95	A	0.90

How to compare ceilings in terms of sound insulation

ROOM TO ROOM INSULATION

The $D_{n,f,w}$ value measured in laboratories represents the longitudinal sound insulation provided by the ceiling (and the ceiling only) between two rooms (room to room sound insulation). Just like sound absorption it is measured at third octave band frequencies and is aggregated into a single figure through comparison with a reference curve.

Due to a change in the standard method of measurement from ISO 140/9-1985 to ISO 10848-2:2006, room to room sound insulation is now expressed by the $D_{n,f,w}$ value which can be considered equal to the former $D_{n,c,w}$ value.

The $D_{n,f,w}$ value is used by designers and acousticians to predict the total sound insulation $D_{nT,w}$ (R'_w, $D_{nT,A}$) between adjacent spaces. The higher the $D_{n,f,w}$ value the better the room to room sound insulation.

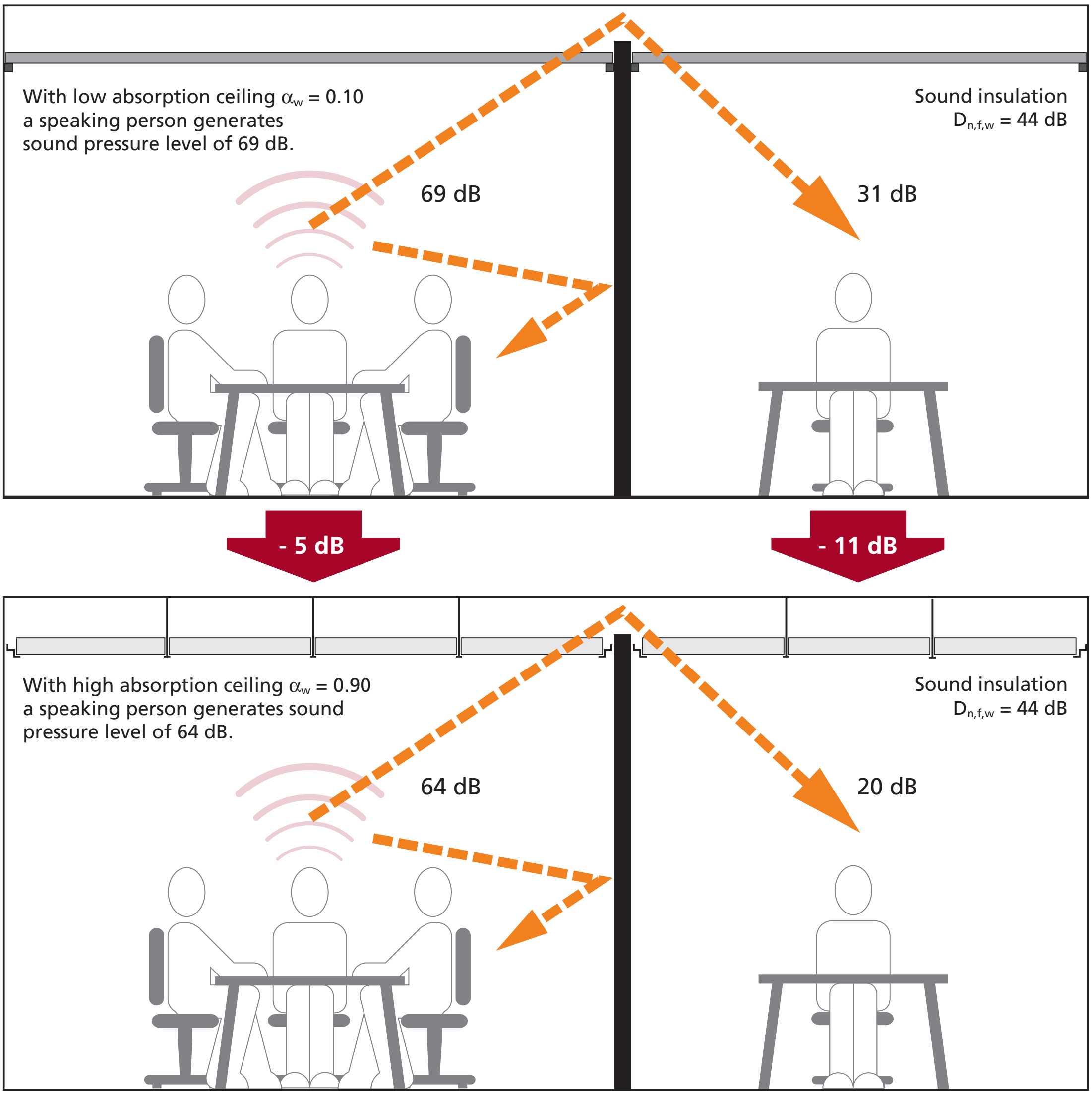
It must be noted that in practice, the presence of sound absorbing material lowers the sound pressure level in a room. When using a highly sound-absorbing ceiling, i.e. $\alpha_w > 0.8$ in the source room, the sound pressure level in this room is reduced. Therefore less sound in the source room means less sound is transmitted to the receiving room. Also, the sound transmitted to the receiving room is further reduced due to the highly sound absorbing ceiling there.

This beneficial effect of high sound absorbing ceilings is not reflected in the $D_{n,f,w}$ values measured in laboratories.

In other words, two ceilings with the same $D_{n,f,w}$ but with different sound absorption coefficients, i.e. $\alpha_w = 0.10$ and $\alpha_w = 0.90$, will result in practice in different perceived sound insulation performance. The ceiling with the highest sound absorption will in reality result in better sound insulation (see figure below). The effect of sound absorption on the resulting sound pressure level can be calculated and has been verified through practical testing.

For rooms in which the separating walls do not extend to the structural soffit, but either stop at or just above suspended ceiling level, it is possible to further improve room to room sound insulation by placing additional sound absorbing overlay material on the ceiling or by the installation of vertical sound barriers. Sound barriers are stone wool based products placed on top of partition walls. Light fixtures and other open services create sound leakage. Acoustic boxes /silencers installed over such services absorb and insulate against the transmitted sound, thus improving sound insulation and helping to maintain the acoustic integrity of the complete installation.

In conclusion, the combined effect of sound absorption and sound insulation can solve most acoustic requirements.

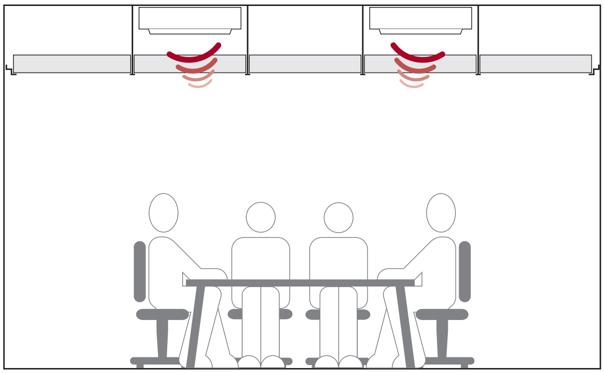


With an identical $D_{n,f,w}$ value (in this case 44 dB), a high-absorbing ceiling contributes to a lower sound pressure level than a low-absorbing ceiling.

DIRECT SOUND INSULATION

The direct sound insulation of a ceiling expressed as the sound reduction index R_W measures the reduction of sound passing through the suspended ceiling. High values of R_W mean good direct sound insulation.

A ceiling with high sound reduction index R_W is extremely important when exposed to excessive noise from service installations in the plenum or when the sound insulation performance of a separating floor construction needs to be improved.



Noise from service installations in the plenum is greatly reduced by ceilings with a high sound reduction index (R_W).

ROCKFON dB PRODUCTS

Rockfon dB products perform best in class with a combination of high sound absorption and high sound insulation.

MAXIMISE SOUND INSULATION AND ACOUSTIC PERFORMANCE

The Rockfon dB range has been designed to block sound from passing through the ceiling and as such can have a significant contribution to both high room-to-room and direct sound insulation. What makes the dB range special is that it provides a unique combination of both outstanding sound insulation and sound absorption in one tile.

Only Rockfon's dB range is available as a class A absorber with up to 44 dB sound insulation. The Rockfon sandwich technology combines a sound-absorbing front surface, air-tightness, and absorption in the plenum, which provides a unique combination of high sound absorption and high sound insulation.

In combination with vertical sound barriers and additional sound absorbing overlay material in the plenum, Rockfon dB products can maximise sound insulation in very demanding situations.

C AND C_{tr} VALUES

To better evaluate the effectiveness of sound insulation on specifc noise sources, the C and C_{tr} adaptation term values have been introduced.
C is the adaptation term for pink noise. It is used to evaluate sound insulation for living activities, i.e. talking, music, radio, TV, children playing, etc.
C_{tr} is the adaptation term for traffic noise. It is used to evaluate sound insulation for i.e. urban traffic noise.
The lower the adaptation factor, C or C_{tr}, the better.

Example: A ceiling with a $D_{n,f,w}$ (C;C_{tr}) value of 40 (-2;**-6**) will reduce traffic noise by 34 dB (40+(**-6**)).

Sonar dB 40 A edge 1200x600mm $D_{n,f,w}$ (C;C_{tr})	Without additional sound absorbing overlay material	With 40mm additional sound absorbing overlay material	With 60mm additional sound absorbing overlay material
	40 (-2;-6)	45 (-2;-7)	47 (-2;-8)

Sonar dB 44 A edge 1200x600mm $D_{n,f,w}$ (C;C_{tr})	No Sound barrier	With Sound Stop 21 dB barrier	With Sound Stop 26 dB barrier	With Sound Stop 30 dB barrier
	44 (-2;-9)	52 (-3;-10)	55 (-9;-17)	58 (-7;-15)

Your challenge, our solution

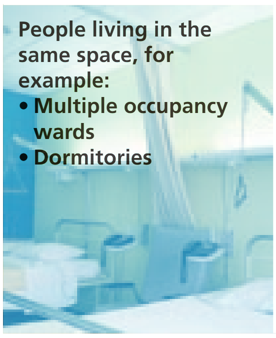
Only problems which cannot be solved are real problems. We have solutions to your acoustic challenges. Get it right with Rockfon!

Today's acousticians and holistic building designers are able to avoid and remedy many noise problems. To do so, they place appropriate absorbing, reflecting and isolating materials into a space.

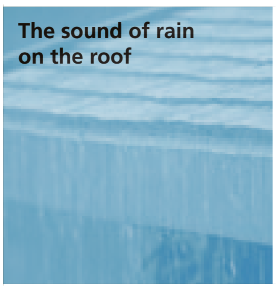
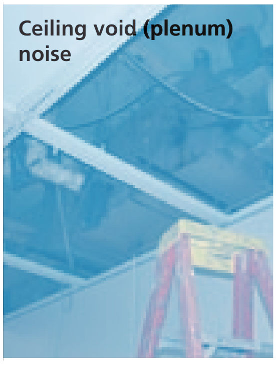
In many cases they will make use of an acoustic ceiling, as this surface is often easy to access. In more difficult or complex situations, wall absorbers, partition walls, acoustical screens, and/or other acoustic elements can be added.

Ideally, of course, appropriate design solutions will be specified by designers and installed during initial building construction. Sometimes, however, designs with poor acoustics can be improved by the addition of appropriate acoustic ceilings and other acoustic materials.

What's frustrating is that it always costs more to implement acoustic treatment after a building is completed than to install it during the initial construction.

Situation	Acoustic challenge	Technical recommendation	Product recommendation
 **A confidential meeting, for example, in the office of a:** **• Manager** **• Lawyer** **• Doctor**	Managers, lawyers and doctors often work with complex issues that require a lot of concentration. So they need a quiet environment. In addition, they often have to pass on sensitive and challenging information. Because of this it is very important that these meetings are held in a calm and friendly environment. Furthermore, it is important that employees, clients and patients can speak up without fearing that people in the neighbouring rooms will hear them.	• For ultimate sound insulation between rooms full height walls are preferable. • High levels of confidentiality and privacy can also be achieved by using high insulating ceilings (>40 dB $D_{n,f,w}$) and/or by installing sound barriers directly above the partition walls. • High absorbing ceilings (α_w >= 0.8, class A or B) are in any case necessary to further improve sound insulation and ensure a calm communication.	Sonar dB Alaska dB Sound barriers
 **Many people talking at the same time, for example, in:** **• Open plan offices** **• Call centres** **• Day care centres/ nurseries** **• Restaurants**	When many people speak at the same time it makes it harder to hear what other people are saying. As a result people tend to speak even louder. This is known as "The Cocktail Effect". This vicious circle can lead to very high sound pressure levels. In day care centres, sound pressure levels of 90 dB (A) have been measured.	• Use class A (α_w >= 0.9) sound absorbing ceilings with maximum absorption in speech frequencies at all incident angles. • Further improvement with wall absorbers or sound absorbing screens that are at least 1.5m in height. • If there is a high level of sound absorption in the room, the sound level will fall even lower than the calculated improvement, since this in itself will make people talk more quietly. One can also improve the sound level somewhat with a few simple measures such as turning off the ringing of phones!	Sonar Activity Sonar Alaska Koral Polar Colour Wall Absorber
 **People living in the same space, for example:** **• Multiple occupancy wards** **• Dormitories**	Studies show that noise not only affects people's moods, but also has a direct impact on the healing process. Despite this, the noise in hospitals has been constantly increasing in the last decades. The acoustic challenges are numerous: Patients have to listen to the sound of visitors, TVs blaring, medical equipment, food being served, beds being moved and rooms being cleaned. This can make it very difficult for patients to sleep in multiple-occupancy rooms.	• High sound absorbing ceilings (α_w >= 0.9) that meet all the other essential healthcare environment requirements.	MediCare Sonar

Situation	Acoustic challenge	Technical recommendation	Product recommendation
The sound of many people working or moving around, for example, in: **• Receptions** **• Shops** **• Shopping malls** **• Waiting areas/lounges** **• Cafes** **• Airports**	When many people walk, clean, cough, phone, eat, play or talk in a larger space the sound this creates can become highly disturbing background noise. This is further aggravated by the fact that many of these spaces are often designed with many hard, highly sound reflective materials such as glass, marble, gypsum or parquet. Nobody wants to spend time or work in a place like this. As a result, customers leave or get a bad impression of the place, and employees do not perform as well as they could. According to Julian Treasure, shops can lose up to 5-10% in sales because of poor acoustics.	• Best performance is achieved by maximizing acoustic surfaces with maximum absorption. • Acoustic ceilings are preferable, but not always possible because of the architecture. If this is the case, the use of islands, baffles and wall absorbers can compensate for the lack of an acoustic ceiling.	Sonar Alaska Polar Colour Single module islands Multi module islands Baffles
Students in a classroom	There are many articles and studies of classroom acoustics - and with good reason: Most schools in Europe were built several decades ago with very little focus on acoustics. The result can be quite devastating. In severe cases students cannot hear/understand up to 70% of the consonants spoken by the teacher. Needless to say, this makes it almost impossible to learn anything. What is primarily required here is low background sound levels, good speech intelligibility and short reverberation times. Reverberation times should be 0.3 – 0.8 second depending on the size of the space and the age of the students. For future proof, all inclusive classrooms, RT should be < = 0.4 seconds at dominant speech frequencies (500-2000Hz).	• Ceilings with high absorption - combined with strategically placed wall absorption at a high level and on the back walls - can help create appropriate room acoustics and compliance with regulations. • For appropriate, reliable levels of sound insulation between classrooms one must use full height walls.	Sonar Scholar Alaska
People listening to a performance, for example, in: **• Lecture halls** **• Auditoriums** **• Movie theatres** **• Concert halls**	Generally these tend to be large spaces that require a high level of acoustic design. It is important to not only achieve the correct reverberation times but also to locate surfaces with different absorption characteristics in different areas of the space.	• A sound reflecting area integrated with the ceiling above the speaking podium to reinforce the sound level to the audience. A highly sound absorbing ceiling (α_w >= 0.9) would be installed in the remaining ceiling area. • Sound absorbing material (α_w >= 0.8) placed on the back and side walls to reduce reflections to the audience that are close to walls and to reduce the likelihood of disturbing standing waves and flutter echoes.	Sonar Sonar Alto Sonar Luna
Sound coming from above, floor-to-room below sound, for example: **• Multi-use spaces** **• Multi-storey buildings**	Everyone knows how irritating the noise of footsteps, objects being dropped etc. on the floor above can be. In new and old buildings the noise of foot steps on hard floors transfer to the room below if no acoustic measures are included. To avoid / remedy this problem, one has to look at the sound insulation provided by the separating floor construction and ceiling underneath.	• The use of dual purpose, high sound absorbing (α_w >= 0.9) and high sound insulation ($D_{n,f,w}$ >= 44 dB) ceilings can achieve significant improvements.	Sonar dB Alaska dB

Situation	Acoustic challenge	Technical recommendation	Product recommendation
The sound of rain on the roof 	In some buildings the background sound levels created by rain on the roof are unacceptable - the rain is simply too loud. Appropriate lightweight roof design - combined with dual purpose sound absorbing and sound insulating ceilings – enables you to meet the best practice acoustic environmental criteria. Rain noise test data in accordance with ISO 140-8: 2006.	• Maximum ambient sound pressure levels when it rains should be only 20 dB(A) higher than during dry weather conditions.	Sonar dB Sonar Scholar Samson
Ceiling void (plenum) noise 	Excessive noise in ceiling voids should ideally be 'addressed' at source, i.e. 'prevention is better than cure'. But if this is not possible, dual purpose sound-absorbing and insulating ceilings can make a significant difference. Ceilings that achieve specific levels of void/plenum to room sound insulation values, but also have "built-in" sound absorption on the "back" as well as the front surface will significantly reduce the noise in and from the ceiling void.	• Maximize the sound absorption on the back of the ceiling / in the ceiling void. • Unlike wet felted mineral fibre, most resin bonded mineral wool - stone wool ceilings have high sound absorption on the exposed surface and the 'ceiling void' surface, which decreases the sound in the void and contributes to a better acoustic environment.	Sonar dB Alaska dB
Areas with limited headroom, for example: **• Stairwells** **• Corridors** **• Basements** 	Stairwells and basements typically have limited headroom and highly reflecting floors. The volumetric needs of traditional suspended ceilings and the actual ceiling height are often in conflict, which makes it hard to provide the required level of sound absorption. Reducing the ceiling void depth has a very negative effect on thin, low absorption materials – and this effect is even more dramatic at lower frequencies. It is important to ensure that the chosen solutions are 'acoustically' documented for the relevant installation depth required.	• High sound absorbing ceilings (α_w >= 0.9) that can be directly fastened to the soffit. Highly absorbent 20mm thick, directly fastened stone wool tiles can achieve the required minimum level, with 40mm thick versions providing much better absorption across a wider frequency range.	Sonar B, C, G edges Sonar Activity B, C, G edges
Thermal mass floors 	Thermal mass is a growing architectural trend with the aim being to use fluctuations in daily temperature as the basis for air conditioning. Since cooling and heating often happens via the structural concrete soffit, a complete 'wall to wall' ceiling solution would make the heat exchange less efficient. Research shows that covering up to 50% of the ceiling area has no significant influence on cooling. With 83% covered, the coefficient is still around 70%. At the same time, the acoustic challenges are the same as in other buildings.	• Improved performance can be achieved by using high sound absorption materials (α_w >= 0.9). • Multi-module islands with high levels of sound absorption (α_w >= 0.9) on both front and back surfaces will absorb sound waves quickly and efficiently, thus ensuring best possible absorption per m² of material used. • Additional absorption can be placed on at least two adjacent walls at high level. Suitable solutions include high sound absorbing ceiling islands which can be suspended and "floating" or directly fastened to the soffit.	**Ceilings** Sonar Activity (direct fix) Sonar (suspended floating islands) **Wall absorbers** Sonar Activity (B, C edges) Samson

Situation	Acoustic challenge	Technical recommendation	Product recommendation
 **The sound of sports events, concerts, people exercising. For example:** **• School sports halls** **• Indoor stadiums** **• Fitness centres**	These spaces often have acoustically hard surfaces and very little thought is given to room acoustics. The result is often extremely poor and unhealthy indoor environments. Because there is so much space and high ceilings, large amounts of sound absorption are essential to create an acceptable acoustic environment. Too many sports halls are poorly designed and quite simply far too noisy and reverberant – which makes it difficult for people to enjoy their leisure time.	• Appropriate reverberation times can be achieved by placing highly sound absorbent materials on ceilings and on walls to reduce the likely effect of flutter echoes and standing waves. • RT < 1.5 second. • α_w ceiling: Min 0.9. • Walls: α_w min 0.8 on at least 40% of area.	Samson
 **Buildings with swimming pools**	Acoustically hard surfaces abound with water being one of the most efficient reflectors of noise. Attention to appropriate reverberation times and reducing echo is vital to ensure adequate speech intelligibility and acoustic safety in the event of public announcements, so that people can enjoy their leisure time in peaceful and safe surroundings.	• Best performance is achieved by maximizing acoustic surfaces with maximum absorption. • Acoustic ceilings are preferable, but not always possible because of the architecture. If this is the case, the use of islands, baffles and wall absorbers can compensate for the lack of an acoustic ceiling.	Sonar Alaska Koral Polar Colour Single – module islands Multi – module islands Baffles